# REMARKS ON A CASE

OF

# COMPOUND DISLOCATION

OF THE ANKLE

WITH OTHER INJURIES;

ILLUSTRATING

# THE ANTISEPTIC SYSTEM

OF TREATMENT.

BY

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# ON A CASE OF

# COMPOUND DISLOCATION OF THE ANKLE WITH OTHER INJURIES.

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*This case was first alluded to in a Lecture delivered February* 14, 1870.

The next case, Gentlemen, which I wish to bring under your notice, is that of a labourer thirty years of age, who was seriously injured on a railway three days ago. He was standing on the line, about a mile out of Edinburgh, at 6 A.M., when he suddenly saw an engine close upon him coming at considerable speed, and he had only just time to turn half round before it struck him on the left shoulder and hurled him to the ground between the rails. On recovering consciousness, he found himself unable to walk; but about half-an-hour later, his cap having been discovered above the buffers of the locomotive, the men in charge of the engine went in search of the owner, and, finding him lying helpless, conveyed him to the Infirmary. When I saw him about 8.30 A.M., he was suffering considerably from shock; and he feared, from severe pain which he felt in his chest, that he had received some serious internal injury,—an apprehension which has happily proved groundless. I

found the left foot much displaced inwards, and the external malleolus protruding through a vertical wound in the integument two or three inches in length. The tip of the malleolus had been broken off, and remained attached to the external lateral ligament; while the extremity of the protruding part was comminuted. The internal malleolus was of course fractured, as a necessary condition of such a displacement of the foot. Now, Gentlemen, if you were experienced surgeons, you would know that this was a most formidable injury. Recoveries from it were formerly exceptional. Mr. Syme informs me that at one time, on looking into the hospital records, he found that the last fourteen cases of compound dislocation of the ankle admitted into the Infirmary had all ended fatally. He therefore came to regard amputation at the ankle as the best treatment in most cases; though he sometimes modified his practice so far as to content himself with removing the end of the tibia, so converting the case into one of excision of the ankle.

In our patient, however, neither of these procedures has been adopted. For the purpose merely of facilitating the return of the protruding malleolus, I nipped off a portion of it with cutting pliers,[1] and, with the same object, enlarged slightly with scissors the lower end of the rent in the skin, which opposed a barrier to its passage. But to all intents and purposes the dislocation was simply reduced. The case, however, was treated antiseptically. Watery solution

[1] The portion removed was covered at its deeper surface with articular cartilage.

of carbolic acid, as strong as it can be made (one part of the crystals to twenty of water), was thrown into the joint with a syringe, the edges of the skin being held together to prevent its escape and cause its penetration to all the internal recesses of the wound; and this was further promoted by free manipulation of the injured part while the fluid was still in the interior. There was a time when we should have thought that to introduce an irritating liquid like this into the ankle-joint would be to take an unwarrantable liberty with the articulation. But we now understand that the transient irritation caused by the antiseptic lotion is nothing compared with the abiding influence of the far more acrid products of putrefaction. In the operation which you saw me perform just now [the removal of a fatty tumour], a lotion of half the strength (1 to 40) was employed; experience having proved that this is sufficient to ensure destruction of the putrefactive organisms in a wound just made, and made by the surgeon himself. But when the injury has been received some time before you see the patient, and inflicted, as in the present instance, in a rude way, involving the chance of foreign material having been introduced and mixed, perhaps, with clots of blood lying in inaccessible recesses of the wound, it seems wise to employ as strong a solution as water will produce. And as this will be your only chance of acting upon putrefactive particles lodged in the interior—as the work of their destruction must be done once for all at the outset—do not be afraid of dealing very freely with the injured part in introducing the germ-poison. [It is a mistake to mingle

spirit of wine or glycerine with the watery solution used for injecting the wound. The admixture of either of these materials with water containing a given amount of the acid in solution, gives it a greater hold upon the acid, and renders the lotion more bland, and at the same time more persistent in its action; and this may, under certain circumstances, be very useful for the purpose of an external dressing. But for the preliminary treatment of the interior of the wound an agent potent for the moment, but transient, is called for, to kill the putrefactive organisms, and, as soon as this is done, to leave the wound as speedily as possible to recover from the inevitable irritation of the antiseptic; and for this purpose no vehicle seems better for the acid than simple water.] The liquid introduced having been squeezed out, the process of injection and manipulation was performed a second time for greater security, and the skin in the vicinity having been previously well washed with the lotion, to destroy organisms adhering to it or to the hairs, an external dressing was applied, similar to that which you have seen used after removal of the fatty tumour. Lac plaster was wrapped in two layers round the limb, from three or four inches above the upper extremity of the wound to as far below its lower end—that is to say, extending well up the leg and embracing the heel and instep; the foot meanwhile being held in good position. A cloth, to absorb the blood and serum which would be discharged from beneath, the margins of the plaster was then bandaged on, and a splint applied to the inner aspect of the leg and foot. [The lac plaster has been very much im-

proved of late, by being incorporated with a soft cloth, instead of being spread upon starched calico. It is thus rendered beautifully flexible, and at the same time much more durable, the cloth incorporated with it enabling it to withstand any amount of wear and tear. But as in this form it is very thin, it is well, where much discharge is anticipated, or when a long time is intended to elapse between the dressings, to use it in two layers, so as to double the store of the acid in the application.[1]]

But, Gentlemen, the compound dislocation of the ankle was not the only injury which this poor man received. Observing some blood about his hair, I examined the head, and found four scalp wounds, varying in length from two to five inches, three of them exposing the bone, into which black dirt had been ground—probably, as he suggests, by the fire-pan of the engine. We used to reckon that when the bone was thus extensively exposed in a scalp wound, and subjected at the same time to such violence, the cure was pretty sure to prove tedious, protracted by the exfoliation of osseous scales of greater or less thickness. There was at the same time more or less risk of head symptoms or of erysipelas. It is, therefore, very satisfactory in such cases to be able to reckon on primary union under antiseptic management. The region occupied by the wounds being extensive, the greater part of the scalp was shaved, and thoroughly washed with this strong antiseptic lotion; and the wounds were dressed just

[1] This plaster in its best form may be obtained from the Old Apothecaries' Company, Virginia Street, Glasgow.

like that at the ankle, except that their edges were approximated by antiseptic sutures. [The material which I have used of late for this purpose is silk steeped for a while in a mixture of melted bees'-wax with a certain proportion of carbolic acid—say a tenth part. As the silk is taken out of the hot liquid, it is drawn through a dry cloth to remove the superfluous wax; after which it may be wound on a reel, and kept in any close vessel. The wax, besides giving the knot a better hold, prevents the antiseptic from being washed out of the thread, and also, filling up the interstices of the fibres, renders the silk incapable of imbibing stimulating liquids; and so confers an unirritating quality corresponding to that of the metallic suture, over which the suppleness of the thread gives it a great superiority.] When all had been stitched up, each wound was once more injected with the strong watery solution, to correct any mischief that might possibly have been introduced by regurgitation of blood that had oozed into the cavity during the insertion of the stitches. A well overlapping cap of lac plaster, in double layer, was then applied, surrounded by a cloth to absorb discharge, secured by bandage and pins.

I cannot too strongly impress upon you the importance of having the plaster extend freely beyond the wound at every part, so that the discharge may have to travel a considerable distance beneath the impermeable antiseptic layer before reaching the sources of mischief externally. It is only in this way that you can guard securely against the spread of the putrefactive fermentation into the wound. Yet there is

nothing in the antiseptic treatment that I find more apt to be neglected.

After I had left the patient, Dr. Cleaver [the house-surgeon] discovered a compound fracture of the right olecranon. The patient thinks he must have fallen upon his elbow; and in this he is no doubt correct, the fracture having been thus caused by direct violence. The wound was not large (about an inch in length), but, from the relations of the bone, it necessarily communicated with the articulation. Here, then, was another injury, in itself sufficiently serious—a compound fracture into the elbow-joint. This Dr. Cleaver treated in a manner similar to that in which I had dressed the ankle, and applied an anterior splint to maintain extension of the elbow.

Now, Gentlemen, I do not hesitate to say that if our antiseptic means succeed as such—that is to say, if putrefaction is prevented from occurring in the wounds—neither of these severe injuries, the compound dislocation of the ankle, the compound fracture into the elbow-joint, nor the scalp wounds exposing and injuring the bone, will occasion either local or constitutional disturbance. You may perhaps think me bold to speak in this confident way at so early a period of the case, at the beginning of the fourth day, the very time when, under ordinary treatment, the region of the ankle would be red, swollen, and painful, preliminary to suppuration, and the pulse rising, with other indications of increasing fever. But the progress of the patient already goes far to justify me. All the injured parts are as yet in a perfectly quiet state, his pulse is daily descending, his tongue is clean and moist, and he relishes his food, and

complains of no pain whatever, except that of the contusions of his chest and shoulder. *You* cannot suspect me of exaggeration, for you have only to go to the patient's bed and inquire for yourselves; and any of you who are disposed to witness the dressing will see it done to-morrow at the visit hour.

But besides the favourable condition of this patient hitherto, I have ample experience to found upon. Since my attention was first drawn to antiseptic surgery I have been concerned in four other cases of compound dislocation of the ankle. One of them was treated in the Glasgow Infirmary just before I left it. The displacement of the foot was inwards, as in our patient, though produced in a very different way.[1] The treatment also was the same; and the wound, which was large, became a superficial sore without suppuration or any local or constitutional disturbance.

Another of the cases was also a dislocation inwards, caused by a lady being thrown out of a dog-cart. She was not under my care, but I was in so far concerned in the treatment that the son of her medical attendant (Dr. Coats, of Glasgow) being at that time one of my dressers, he was asked by his father to employ the means which he had seen me use at the hospital. In accordance with my practice at that time, an oily solution of carbolic acid was introduced into the joint and into the rest of the wound, and a layer of putty, rendered antiseptic by the admixture of a certain proportion of the acid, was used for the external dressing. The means were different, but their object was the same.

[1] See *The Lancet*, Jan. 1, 1870.

The oily solution destroyed organisms existing in the wound; and the putty, like the lac plaster, impermeable to watery fluid, communicated the volatile antiseptic stored up in its substance to the discharge that flowed out beneath it. The case was published by Dr. Coats,[1] who told how, after the first smarting caused by the acid had subsided, the patient was free from the pain previously experienced, and never after had any uneasiness in the part. Here also the wound closed without any deep-seated suppuration or any febrile disturbance.

In a third case, a gentleman about sixty years of age, of heavy frame, slipped in going down-stairs, and the foot was driven forcibly outwards, the fibula being broken, while the internal malleolus was thrust through the integument. I saw the patient in conjunction with Dr. George Buchanan of Glasgow; and Mr. Berkeley Hill of London, happening to be on a visit to me at the time, witnessed the first dressing. The lac plaster was used, but in a way which I have since abandoned, so that I need not trouble you with its details. [After the joint had been injected with watery solution of carbolic acid, and the dislocation reduced, a bit of thin block tin was placed over the wound to protect it from the stimulating action of the acid in the plaster wrapped round the foot. This was surrounded with a cloth and bandage, which were afterwards daily touched with a strong solution of carbolic acid in oil, to renew a supply of the antiseptic to the lac beneath, which was permanently retained. The tin has since been superseded; and I have found it, on the whole, better to change the entire

[1] See *The Lancet*, May 2, 1868.

dressings occasionally, in the manner to be described in the sequel.] Though the patient was of gouty habit, and in other ways by no means a very favourable subject, his progress was all that could have been desired had the case been one of simple fracture. [Not one drop of pus appeared till, five weeks having elapsed, and a little serous discharge still continuing, the deeper dressings were removed for the first time, and disclosed a superficial sore with pouting granulations, which healed in a few days under an astringent lotion.]

The fourth case was one in which the injury was inflicted by myself, but was of the same essential nature as those caused accidentally, though its effect was to remedy, not to produce, displacement. The foot had been driven backwards and outwards by the violence which occasioned a simple fracture of the fibula and internal malleolus four months before; and the faulty position having continued during the union of the fragments, the limb was perfectly useless, and the patient, a young man of twenty-nine, had the prospect of going on crutches for the rest of his life. Relying on our antiseptic means, I did not scruple to divide with pliers the callus of both tibia and fibula, though I knew that in so doing I was opening into the ankle-joint. For the case differed in this important particular from those which result from accident, that I could guard with certainty against the introduction of putrefactive mischief while making the wounds; whereas in the accidental cases we cannot help feeling a degree of uncertainty till the first few days are over, whether the organisms introduced before we see the patient have

been all destroyed, though in truth the method by injection and manipulation which I have described seems to have reduced this to something very nearly approaching certainty. The foot having been drawn forcibly into its proper position by means of pulleys, and retained by appropriate splints, while an external antiseptic dressing was employed on the same principle as the putty and lac plaster, though of different materials, the wounds became superficial without suppuration and without the slightest inflammation or fever;[1] and I have the satisfaction of knowing that he, like the other patients, has now a sound and useful foot.

You see, then, Gentlemen, that I had reason for the confidence with which I expressed myself.

*In a Lecture on the* 17*th of February the following remarks were made:—*

The case of complicated injury which we were considering three days since goes on in accordance with our anticipations; and I wish now to say something regarding its subsequent management and progress.

The dressings were changed entirely on the day after the accident. [In doing this the greatest care is requisite. For the antiseptic injected into the wound on the previous day having been absorbed into the circulation, the extravasated blood, and any portions of tissue killed by the violence of the injury, are as susceptible of putrefaction as if no such treatment had been pursued; and my experience leads me to believe that if, when the

[1] For further details of this case, see *The British Medical Journal*, Oct. 31, 1868.

dressings are removed, a single drop of serum were to be pressed out by the movements of the limb and then regurgitate into the interior, after being exposed even for a second to the influence of septic air, putrefaction would be pretty certain to occur. The skill required to guard against this risk during the first few days, before the wound has consolidated, used to be a serious drawback to the treatment. But the difficulty and uncertainty arising from this cause have been changed to facility and security by a most simple means—the employment of a syringe, the nozzle of which is inserted beneath the margin of the lac plaster, and, as this is raised, a stream of weak watery solution of carbolic acid (1 to 40) is made to play upon the wound till a piece of calico, soaked with the same lotion, has been placed upon it by an assistant, as a temporary security until the plaster is reapplied. Any examination of the wound that may be desired is made with freedom through the transparent solution thrown over it by the syringe, the wound bein never left for an instant without an antiseptic guard. The cloths outside the lac plaster adhere to its edges through drying of the discharges which they absorb, and care must be taken in removing them to hold the plaster down over the region of the wound, sothat it may not be, even for a moment, dragged up along with them. These details, while essential to success, are, happily, easy of execution.[1]]

The dressing on the day after the accident and subsequently has differed from that used in the first instance in this respect, that, before applying the lac plaster, the

[1] The remarks included within these brackets were made on another occasion.

wound itself was covered with a layer of material designed to protect it from the stimulating and irritating influence of the carbolic acid in the antiseptic stratum. You have often seen this "protective" in use in other cases, but I desire now to direct your attention to it more particularly.

Of all those who use antiseptics in surgery, I suspect that I apply them least to the surface of the wound. After the first dressing, the object which I always aim at is to have the material in contact with the exposed tissues approximate as closely as possible to the perfectly bland and neutral characters of the healthy living textures. If you consider the circumstances of a simple fracture, which you cannot too often call to mind if you wish to keep your ideas clear and right upon this subject, —if you remember how the severe contused internal wound, with the interstices of the mangled tissues loaded with extravasated blood, recovers quickly and surely under the protection of the unbroken integument, it is plain that all that is required in an external wound is to guard it against the disturbing influence of external agency. The injured tissues do not need to be "stimulated" or treated with any mysterious "specific;" ALL THAT THEY NEED IS TO BE LET ALONE. Nature will then take care of them: those which are weakened will recover, and those which have been deprived of vitality by the injury will serve as pabulum for their living neighbours. Now, of all external agencies the most injurious by far is putrefaction, and this, above all, we endeavour to exclude. But a substance employed with this object, if sufficiently potent to destroy the life of the putrefac-

tive organisms, cannot fail to be abnormally stimulating to the exposed tissues; and these must be protected from its action if the wound is to progress exactly like a subcutaneous injury.

Our "protective," then, should be a material unstimulating in its own substance, and impervious to carbolic acid. At the same time it must be insoluble in the discharges, and sufficiently supple to apply itself readily to the part. But it is by no means easy to find anything fulfilling all these conditions. Gutta percha or caoutchouc, which naturally suggest themselves, transmit the acid from particle to particle of their substance with the utmost facility, and are utterly useless for this object. A metallic plate is quite impervious to the acid. But thin block tin, which I once used, is too rigid, while tinfoil soon wears into holes. I have been lately trying a microscopically thin layer of metal, in the form in which you see it in this specimen. Cotton cloth, coated on one side with caoutchouc, is gilded on the caoutchouc side, and then covered with a film of india-rubber applied in solution. We have ascertained that the gold-leaf thus enclosed between two layers of caoutchouc spread on cloth wears thoroughly well; and, if I can get a manufacturer to enter into the thing, I have hopes of obtaining at last something like a perfect protective. And when this is attained, as the lac plaster is quite trustworthy for excluding putrefaction, our treatment will yield to the full the beautiful results which theory indicates as possible.

There is one more point that must be mentioned with reference to the protective. It is essential that it should

be itself antiseptic at the moment of its application, otherwise there would be a risk of its communicating septic particles. This object can be attained by covering it with an extremely thin film of some material soluble in water; so that when dipped into a watery solution of the acid it may be uniformly moistened with the antiseptic, but in so small a quantity as will be rapidly absorbed by the wound and by the skin, so as not to interfere to any material extent with the purely protective office of the application. You will bear in mind that the protective is not designed to have any persistent antiseptic virtue; and that, like the wound at the first dressing, it must be freely overlapped at every point by the antiseptic plaster.

These principles will be found to apply whatever be the materials used for carrying out the antiseptic system. *An antiseptic to exclude putrefaction, with a protective to exclude the antiseptic, will by their joint action keep the wound free from abnormal stimulus.*

Though we have not yet got a perfect protective, that which we are now generally using answers very fairly, and has this advantage—that the materials for it can be obtained from any druggist's shop. The basis of it is the common oiled silk. I am indebted to my late house-surgeon, Dr. Joseph Coats, now Pathologist to the Glasgow Royal Infirmary, for calling my attention to the fact that carbolic acid does not pass nearly so readily through oiled silk as through gutta-percha. But if oiled silk is dipped into a carbolic lotion before applying it, the watery fluid runs from the surface as from a duck's back, and there is risk of septic particles being deposited

upon the dry parts, even during the rapid transfer from the vessel containing the lotion to the wound. I had reason to suspect that, in some cases of hollow wounds, putrefaction was actually brought about from this cause; and hence I was induced to abandon the oiled silk for a while. But of late I have had it coated with a soluble film, which entirely removes this objection. The oiled silk is brushed over with a mixture of one part of dextrine, two parts of powdered starch, and sixteen parts of cold watery solution of carbolic acid (1 to 20). The carbolic-acid solution is used rather than water, not for its antiseptic property, but because it makes the dextrine apply itself more readily to the oiled silk, and the granular starch is used for a similar purpose. The carbolic acid may be afterwards allowed to fly off without disadvantage; so that there is no need for keeping the protective, like the antiseptic plaster, in a close vessel. Oiled silk thus prepared becomes uniformly moistened when dipped in a watery solution of the acid, so that all risk of communicating putrefactive mischief along with it is avoided; and if it be used in two layers it opposes a pretty effectual barrier to carbolic acid, as is sufficiently illustrated by the progress of the present case.

On the day after the accident the cloths around the lac plaster applied to the ankle, and even the pasteboard splint and its padding, were found soaked with bloody discharge. On the second day, when the dressings were again changed, the cloths presented only a stain corresponding to a few drachms of tinged serum; so that I thought it safe to allow two days to pass before the next dressing. I believe it to be best in all cases to

change everything on the day following the injury; because the effusion from the wound is then of a bloody character, and though the lac plaster certainly sheds the discharge admirably, yet it is possible that a layer of clot may be lying beneath it, which might interfere with its antiseptic operation. But after the first day, sanguineous effusion having ceased, the interval between the times of dressing should be regulated by the amount of discharge to be anticipated; for the more copious it is, the sooner does it exhaust the carbolic acid in the plaster. The lac may happily be always trusted to retain enough of the acid for twenty-four hours, however free the discharge may be. If the stain on the cloths indicates an effusion of only a few drachms, the plaster may be safely left for two days. If the serous oozing be not more than a few minims, the interval may be extended in proportion to the smallness of the amount, till finally, when, as sometimes happens, the plaster is maintained as a precautionary measure though no discharge is present, it may be left for a week without losing its antiseptic virtue. When the interval between the dressings is thus prolonged, the pains taken during the first few days are rewarded by great saving of trouble, as well as by the satisfactory progress of the patient; and when the case is one of fracture, the avoidance of frequent disturbance of the limb is of course a matter of most material consequence.

At the next dressing, four days after the accident, the ankle presented an appearance which would have been impossible without antiseptic management. The hollow wound, about three inches long, and gaping about an

inch, was still occupied by the original coagulum on a level with the surrounding skin; while the discharge of the last two days had caused only a serous stain of a few minims on the cloths. But this state of things was not merely the result of *antiseptic* treatment. It implied that our *protective*, also, was answering its purpose well. Had the antiseptic been acting directly on the wound, the discharge would have been much more considerable, and we should probably have already had a hollow sore with commencing suppuration. Here I cannot help observing that it seems to me strange that some who have not scrupled to criticise me with great severity should have taken so little trouble to ascertain what I have written on this subject. From the remarks made by some persons, you would imagine that I regard putrefaction as the sole cause of suppuration; whereas my treatment of abscess depends essentially upon the fact that the pus in the unopened cavity, being the result of the inflammatory stimulus without [illegible] influence, is free from putrefaction, so that [illegible] to apply the antiseptic to the interior, all that [illegible] being to provide exit for the discharge wh[illegible] against the entrance of putrefactive ferm[illegible] from the statements of others you would suppose me to have taught that, if you do but apply carbolic acid freely to a wound, you will prevent suppuration; whereas I have all along pointed out that carbolic acid, being a stimulating substance, will itself induce suppuration by long-continued action on the tissues.[1]

[1] See *The Lancet*, March 16th, 1867, and Sept. 21st, 1867; also *Brit. Med. Jour.*, Nov. 14th, 1868.

[The facts observed in developing the antiseptic system have thrown great light upon the causes which determine the occurrence of suppuration; and the subject is of such great practical importance that it may be well to take this opportunity of giving definite expression to the conclusions to which I have been led. It fell to my lot several years ago to establish, as the result of an experimental inquiry, that the tissues of the living body are liable to a temporary impairment or suspension of vital energy as the result of extreme irritation; and that this condition, which appears to be the essence of *intense* inflammation, may be brought about in two totally distinct ways—viz., either by the direct operation of a noxious agent upon the tissues, or indirectly through the medium of the nervous system.[1] The same law appears to hold with regard to the causes of the exaggerated but feeble cell-development which results from the continued action on the tissues of some [illegible] stimulus in a less intense form, giving rise, according to its degree, to the various phenomena of [illegible]ry hypertrophy, granulation, and suppura[illegible]us-cells being the extreme of excess of quan[illegible]ent of quality in the product of abnor[illegible]nutrition. Thus the causes of suppuration divide themselves into two great groups: first, those that operate through the nervous system, or, in other words, the inflammatory class, of which the common abscess presents a typical example; and, secondly, noxious agents or stimuli acting directly on the tissues. The latter group are, practically speaking, stimulating

[1] "On the Early Stages of Inflammation."—*Phil. Trans.* 1858.

salts, or chemical stimuli. These are best studied in the behaviour of a healing ulcer under different kinds of treatment. Small granulating sores sometimes heal by scabbing; and when the surface is thus protected by a crust of dried discharge from the influence of external agency, there is no further effusion either of pus or serum. This is of itself sufficient evidence that granulations have no inherent tendency to form pus (or, as is sometimes absurdly said, to *secrete* it), but only do so when stimulated. The same thing is equally clearly shown by the well-known fact that two granulating surfaces will coalesce when placed in contact with each other. This coalescence would be impossible if they continued to suppurate; and their juxtaposition could oppose no obstacle to pus-formation if they had any innate disposition to it. But their mutual contact excludes the operation of external agents upon them; being freed from stimulation, they cease to discharge; and they are then at liberty to coalesce. New examples of the same truth present themselves under the antiseptic system of treatment. The wall of an abscess is similar in nature to the granulations of a sore, and is often regarded as essentially "pyogenic." But if the abscess is opened antiseptically, the pyogenic membrane, being relieved from the inflammatory stimulus which the tension of the pus before induced, and being at the same time protected from the access of the stimulus of putrefaction, is left free from all disturbance, and never forms another drop of pus. But the most striking illustration I ever saw of the properties of granulations, when not subjected to stimulation, was presented by a case of com-

pound fracture, in which an extensive portion of the shaft of the tibia had lost its vitality, and lay exposed in a large granulating sore. The granulations grew up and enclosed the dead bone, which, being prevented from putrefaction by the treatment employed, was destitute of the usual acrid properties of an exfoliation; so that the granulations, being not stimulated by it, not only formed no pus from the surface in contact with it, but gradually consumed the dead mass by absorption.[1]

The truth is, that so far from granulations having any inherent tendency to form pus-corpuscles, the imperfect tissue of which they consist is ever disposed to develop into higher forms as soon as it is left free from preternatural excitement. This is beautifully illustrated by the familiar phenomena of the healing ulcer. The granulations are still granulations—that is to say, possess still the same pathological structure, when covered by the pellicle of newly-formed epidermis at the edge of the sore, as when they were exposed. But no sooner does the film of young epithelium protect the imperfect tissue from the influence of external stimulus than the rudimentary structure of the granulations immediately proceeds to develop into the more and more perfect fibrous tissue of the cicatrix.

It being, then, clearly understood that granulations form pus only when abnormally stimulated, we are in a position to estimate the effects of different agents upon them. The simplest case is when an antiseptic substance, like chloride of zinc or carbolic acid, is applied,

[1] See *The Lancet*, March 23, 1867.

suitably diluted, to a healthy granulating sore. Not the slightest redness of the surrounding skin, or any other indication of inflammatory disturbance, is produced; yet the granulations, so far as they are exposed to the influence of the stimulating liquid, are excited to superficial suppuration, but form no pus where they are protected from the stimulus by the pellicle of epidermis at the margin. Here, then, we have entire absence of the inflammatory stimulus; but the chemical stimulus of the pungent antiseptic salt urges the superficial cells of the granulations to develop pus-corpuscles.

If the sore is treated with water-dressing, the serum first exuded putrefies in the lint, and the products of putrefaction, being acrid salts, cannot fail to stimulate the surface of the granulations; and accordingly superficial suppuration is induced without any appearance of inflammation, just as under the influence of the antiseptic. Thus, in their effects upon a granulating sore, an antiseptic and a putrid dressing are alike: both excite superficial suppuration by direct chemical stimulation of the granulations. But in their operation on a recent wound there is this all-important difference between them, that the antiseptic stimulates only the surface to which it is applied, and every drop of discharge which it induces dilutes it and renders it less stimulating; but putrefaction being a fermentation, the self-propagating ferment spreads throughout all the recesses of the wound, wherever extravasated blood, or serum, or portions of dead tissue afford nidus and pabulum for its development, and its products become more and more acrid the longer it continues in operation. Antiseptics, then,

though they do produce suppuration when applied continuously to a recent wound, are superficial in their action and utterly trivial compared with the deep and virulent effects of putrefaction, which, indeed, often causes death by irritation and blood-poisoning before suppuration has had time to be established.

These conclusions may be exhibited in a diagrammatic form as follows :—

*Causes of Suppuration.*

| | | | |
|---|---|---|---|
| Abnormal stimulation of the tissues, | A | Through excited nervous action. | *Inflammatory.* |
| | B | From the direct action of stimulating salts. | *a. Putrefactive.* |
| | | | *b. Antiseptic.* |

This scheme, though not strictly exhaustive,[1] applies to almost all circumstances met with in surgery ; and it will be found to conduce to clearness to speak of suppuration as inflammatory, putrefactive, or antiseptic, according to the circumstances in which it occurs.[2]]

If the use of the protective be so advantageous, you may naturally inquire why I do not employ it at the first dressing. The reason is twofold. In the first place, there must necessarily be a considerable discharge of blood and serum during the first twenty-four hours, and hence this is the period in which there is greatest risk of

[1] The group *a* ought to include the products of other ferments besides those of putrefaction. For I am satisfied that inodorous ferments sometimes occur in the animal fluids, and produce salts which stimulate to suppuration. Also viruses inducing suppuration are very probably of the same essential nature (ferments), though some at least are odourless, as in the case of erysipelas. Again, the group *b*, to be complete, should include salts which, though not the products of putrefaction, cannot be said to be antiseptic, such as dilute chloride of sodium, etc.

[2] Any special case, not falling under the scheme, may be called according to its special nature ; thus we may speak of erysipelatous suppuration, variolous suppuration, etc.

putrefaction spreading into the wound, so that it does not seem wise to interpose anything that can interfere in the slightest degree with the antiseptic action of the dressing. And, in the second place, there is no chance of a suppurating sore being established by the direct action of the antiseptic upon the wound for a single day only. This leads me to speak of a condition of suppuration to which I have not before had occasion to advert—viz., the element of *time*. When the tissues are in a healthy state, no stimulus can induce them to suppurate. It appears that it is only when the tissues have been gradually degraded, under the influence of protracted abnormal stimulation, into the most imperfect of all tissues, which, when we see it at the surface of a sore, we term granulations, that they are in a condition, if further stimulated, to give birth to the still lower progeny of pus-corpuscles. In other words, granulation must precede suppuration, and it is a process which requires days for its completion.[1] Thus it is a familiar fact to all surgeons that a recent wound in healthy tissues does not suppurate for three or four days when subjected to ordinary treatment—that is to say, the stimulus of putrefying material must act for three or four days upon the tissues before it can induce them to suppurate; and when the first-formed pus is wiped from the wound, granulations may be seen upon the surface.

[1] An exception to this statement must be made for the case of the epithelium of some mucous membranes, the cells of which, originally of simple structure, soon form pus-corpuscles under slight abnormal stimulation. While thus adopting the language of the "Cellular Pathology," elaborated by Virchow and others following the path first opened up by Goodsir, I may remark that my own experience has tended to convince me of the truth of that doctrine.

The same holds with regard to the inflammatory stimulus. Inflammation does not produce suppuration in a day. Whether acute or chronic, it must first degrade the tissues to granulations before it can occasion the formation of pus. This is well illustrated by a common boil, which is a limited inflammation of the cutis vera, so severe at the centre as to destroy the vitality of a portion of the tissue, and gradually shading off to the state of health in the vicinity. Here, though all possible degrees of intensity of inflammation are present between the centre and the circumference, no pus is produced till some days have elapsed. Then the "core separates," as it is said, and the slough is found detached from the neighbouring living tissues, and surrounded by a few drops of odourless pus. But when the slough and the pus are removed, the cavity in which they lay is seen to be lined with granulations. The inflammatory stimulus, like the putrefactive, had induced granulation as a preliminary to suppuration.

In the same way, an antiseptic must act for days upon [illegible] before it can convert it into a granulating sore [illegible] suppuration; so that no harm is done by [illegible]ing the protective for the first twenty-four hours.

The other injuries in our patient have thus far proceeded as satisfactorily as that of the ankle. The four severe scalp wounds were dressed on the day after the accident, and each was covered with protective before the cap of lac plaster was reapplied. On the following day, the discharge to be seen on the cloth round the lac was so slight that I thought it safe to leave the head undisturbed for another day. The second dressing was

witnessed by some of you just after last lecture. The discharge of the two days amounted to only a few minims of serum, and there was entire absence of redness, puffiness, or tenderness of the scalp. I removed the numerous sutures, each coming out as clean as when it was introduced; and all the wounds seemed already completely healed, except a small superficial raw surface here and there.

The compound fracture into the elbow-joint, when last dressed, presented only a trace of serous discharge, so that I shall not think it needful to disturb it till five days shall have passed since that occasion.

*The following remarks conclude the case:—*

Before proceeding to relate the further progress of this case, I have to direct attention to another circumstance of great practical importance in the injury to the ankle. On the day after the accident it became apparent that the violence to which the part had been subjected had destroyed the vitality of portions of the integument, not only at the anterior margin of the wound, where a slough about half-an-inch in breadth existed, but also in detached patches at the outer aspect of the dorsum of the foot. Now, if any one of these dead pieces of skin had been left exposed to atmospheric influence, it would have putrefied; and the putrefaction would in all probability have spread along the extravasated blood and serum in the subcutaneous tissue till it had reached the seat of fracture and the articulation, and all our antiseptic treatment of the wound would have proved nugatory. I once saw a case

of compound fracture of the forearm, in which the antiseptic treatment had been pursued with thoroughly efficient means, but after the lapse of some days I was asked to look at the limb, in consequence of unsatisfactory appearances. I found the dressings applied perfectly correctly, and I had no reason to doubt that they had been so from the first; but the wound, when exposed, emitted an offensive discharge. On investigation I found a small slough of the skin, about half-an-inch in diameter, situated some inches from the wound, and just beyond the limits to which the lac plaster had been extended. The little slough had by this time undergone softening from putrefaction, so that the nozzle of a syringe could be introduced through it; and, on injecting some of the watery solution of carbolic acid, I found that it passed freely beneath the integument to the seat of fracture and to the external wound. Whether the skin had been thus extensively detached at the time of the accident, or whether the subcutaneous tissue had been simply loaded with extravasated blood, the spreading of the putrefactive fermentation from the slough exposed to the air was easily intelligible.

It is therefore essential that every isolated slough which may exist in the vicinity of a contused wound should be dressed antiseptically like the wound itself. But it may be asked, how is it possible to secure this at the time of the first dressing, seeing that there is nothing in the appearance of the skin in the first instance to indicate that vitality has been destroyed? The simple rule for attaining the desired object is to let the antiseptic plaster first applied overlap the ap-

parently uninjured skin far and wide in all directions. Then, on the following day, let the integument be carefully scrutinized, when any dead portions will be recognised by a dusky discoloration. Every such discoloured patch should then be dressed, as if it were a wound, with a piece of protective and well-overlapping lac plaster. If the protective were omitted, the slough would acquire stimulating properties from the carbolic acid perpetually communicated to it by the lac plaster, and would excite the neighbouring living parts to granulation and "antiseptic suppuration." But if efficiently protected from the antiseptic, as well as from putrefaction, the dead tissues will be absorbed and organized like the clots of blood, new living structures being formed at the expense of the effete but nutritious mass.

Such was the course pursued in the present case; and, the oiled silk protective having been used in two, and sometimes three, layers, the results have approached very closely to those which are theoretically attainable. Some of the smaller portions of slough have been entirely removed by absorption, their place being taken by vascular new tissue. Five weeks after the accident, the large slough at the anterior margin of the wound had been considerably reduced in superficial extent, without the formation of any line of separation. What remained of it was of firm consistence, though of yellowish-white colour. In order to ascertain to what extent the process of organization and vascularization had advanced in it, I scratched its central part with the point of a sharp knife, and found that the little incision bled when I reached a depth not above half that of the

cutis vera, whereas the original slough had undoubtedly involved, not only the entire cutis, but the subcutaneous fat. The mass of dead tissue, though superficially situated, being protected from the disturbing influence of external agency, was undergoing the same kind of change as is experienced by parts deprived of vitality in the subcutaneous injury of a simple fracture.

The appearances of the wound itself presented an equally striking difference from those met with under ordinary treatment. Even at that late period, five weeks after the accident, the original clot was still to be seen, of an orange-brown colour, on a level with the surrounding skin, but greatly diminished by contraction and also by cicatrization, epidermic formation having advanced considerably from all parts of the margin of the wound, except anteriorly, where the slough was present. An open sore healing by cicatrization without suppuration, or even granulation, is something new in the history of surgery, though exactly what might have been expected from what we know of healing by scabbing. At the lower extremity of the wound the new and vascular tissue which had been formed by organization of the clot was slightly more prominent than the rest, and had somewhat the characters of granulations covered with epidermis. But not a trace of pus had been produced. On the occasion when these observations were made, eight days had been allowed to pass since the last dressing, and in order to estimate accurately the quantity and quality of the discharge, I removed the lac plaster without injecting any watery solution beneath it, knowing that at this late period no risk

would be incurred by free exposure of the wound. The bandage outside the plaster being free from stain, the whole discharge of eight days had accumulated beneath the impermeable layer of lac, and consisted only of about two minims of white but thin fluid, together with some desquamated epidermis. I subjected the milky liquid to microscopic examination, and found that the opaque element was composed exclusively of epidermic scales.

The vascularization of the clot, like that of the sloughs, had been advancing from below as well as round the margins. Fifteen days after the accident I cut into the central part of the then chocolate-coloured coagulum, under the protection of a stream of watery solution of carbolic acid, and found that it did not bleed, though the knife penetrated about a quarter of an inch. But on a repetition of the experiment twelve days later, blood oozed up from an incision carried to only about the depth of an eighth of an inch.

The process of organization of clots and sloughs thus observed in an external wound, though of the same essential nature as that which occurs in subcutaneous injuries, was undoubtedly retarded by a certain degree of abnormal stimulation inseparable from the method of treatment. For, besides the fact that the protective was not perfect—*i.e.*, not absolutely impermeable to the carbolic acid furnished by the lac plaster—the clot and sloughs were more or less soaked with the antiseptic lotion every time the dressings were changed; and though the acid is soon diffused and carried away by the circulation, this circumstance necessarily operated

as a disturbing cause. Hence the rate of healing will be more rapid in proportion to the efficiency of the protective, and also to the length of the intervals that can be allowed to pass between the dressings consistently with security against putrefaction. In the present case, the period between the dressings was extended as the discharge diminished, and it may be worth while to mention the successive intervals. From the date of the accident they were as follows :—one day ; one day ; two days ; three days ; three days ; five days ; five days ; seven days ; and finally eight days ; bringing the time up to five weeks from the receipt of the injury. But I am not prepared to recommend a longer time than a week, and even that only when the discharge is practically *nil.* Indeed, in our patient, putrefaction did take place in the period following that of eight days. I had intended allowing another week to pass before meddling with the limb, but at the close of the sixth day my house-surgeon informed me that the patient had got up two days before, without leave, and had made his way, on chairs as crutches, to the fire, a distance of several yards ; and, further, that there was an appearance of a stain upon the bandage. I therefore exposed the limb, and found that the discharge was considerably greater (amounting to perhaps half a drachm), fetid, and, for the first time since the accident, unmistakably puriform. The dressings removed on the last occasion had been perfectly odourless ; and the most probable explanation seemed to be, that the vascular engorgement of the limb occasioned by the dependent posture had induced an unusual exudation

of serum from the wound, and that this circumstance, combined perhaps with some movements of the foot, had proved too much for the antiseptic power of the lac plaster at that period after its application. Happily the occurrence was of no consequence, as the wound was practically superficial, and beyond the reach of danger from putrefaction. But it may serve as a warning. And it must ever be borne in mind that, in the earlier stages of such a case as this, where the avoidance of putrefaction may be a matter of life and death, it is better to err on the side of dressing too often, rather than too seldom.

The putrefaction had evidently occurred quite recently, for the clot and sloughs were not yet detached. I clipped away most of the slough, and scraped off the clot till I got down to bleeding tissue, and, with the view of correcting the putrefaction in such portions of dead material as remained, I treated the sore with a strong solution of carbolic acid in spirit of wine (one part to five), and, having washed the skin around with watery solution, applied lac plaster, omitting the protective. Next day, however, the putrefaction was reproduced; showing that the antiseptic employed had not thoroughly penetrated the adhering portions of slough. Having at hand some saturated solution of chlorine gas in water (the liquor chlori of the British Pharmacopœia), I applied it freely to the sore and also to the surrounding integument, and then dressed with protective dipped in chlorine water and covered with overlapping lac, as formerly. On the following day the sore was destitute of odour of any kind, while the dis-

charge was greatly reduced. For the future it will be treated as a superficial ulcer.

With regard to the injury to the ankle, it only remains to be mentioned that, at the present time, six weeks after the accident, the fracture of the internal malleolus has united firmly, and the foot is in good position; while the patient has already considerable movement of the ankle-joint.

The four severe scalp wounds—three of which, it will be remembered, involved exposure and injury of the bone—healed completely, without the formation of a drop of pus. And it was an interesting circumstance that, on the removal of some scabs, one of the silk sutures, which had been accidentally left, was found still securely in its place, three weeks after its introduction, and came away clean and dry, like a metallic stitch.

The compound fracture into the elbow-joint also healed without any suppuration. Five weeks after the receipt of the injury the splint was removed. The broken olecranon was found firmly united, and the patient has now free motion of the articulation.

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